A MICROSCOPE-STAGE INCUBATOR

J. THOS. PATTERSON.

The desirability of studying the living egg in connection with any embryological investigation has long been recognized, and the excellent results obtained from such studies have demonstrated repeatedly the advisability of putting forth every effort to overcome any obstacles that might stand in the way of such observations. Hitherto direct observations on the developing bird's egg have not been possible, for such a study is beset with many difficulties, chief among which is that of incubation. In an endeavor to overcome this difficulty I have been led to devise the following *microscope-stage incubator*, which not only fulfills my purpose admirably, but also gives promise of being useful in the study of other biological problems, especially those in which it is necessary to maintain a constant temperature while making direct observations on the living organism.

The photograph (Fig. 1) shows the apparatus connected up and ready for use with a compound microscope although a binocular can be used as readily. The incubator consists of a galvanized-iron tank, a portion of which fits over and in front of the microscope stage. Just above the center of the stage a hole is cut in the lid of the tank and in this is placed a covered dish, or egg-cell *e*. This arrangement allows one to study the egg readily and at the same time to make camera drawings of the object under observation.

The water in the incubator is heated by a sixteen-candle power incandescent lamp *l* connected with a thermoregulator *r*, which is patterned after the glycerin type described by Mast (*Science* for October 25, 1907). The bulb or immersed part of the regulator is bent at right angles to the upper portions, in such a way that it extends towards the microscope stage, reaching almost as far as the egg-cell. This arrangement not only places the bulb directly in the path of the current which flows from the

incandescent to the egg-cell, but also increases the size of the bulb, and thus increases the sensitivity of the regulator.

For my purpose, the regulator is adjusted so as to maintain a temperature of about 39.4° C. in the neighborhood of the thermometer *t*, which is placed as close to the egg-cell as will permit an easy manipulation of the objectives. In order to keep the temperature constant it is necessary to have a circulation of the

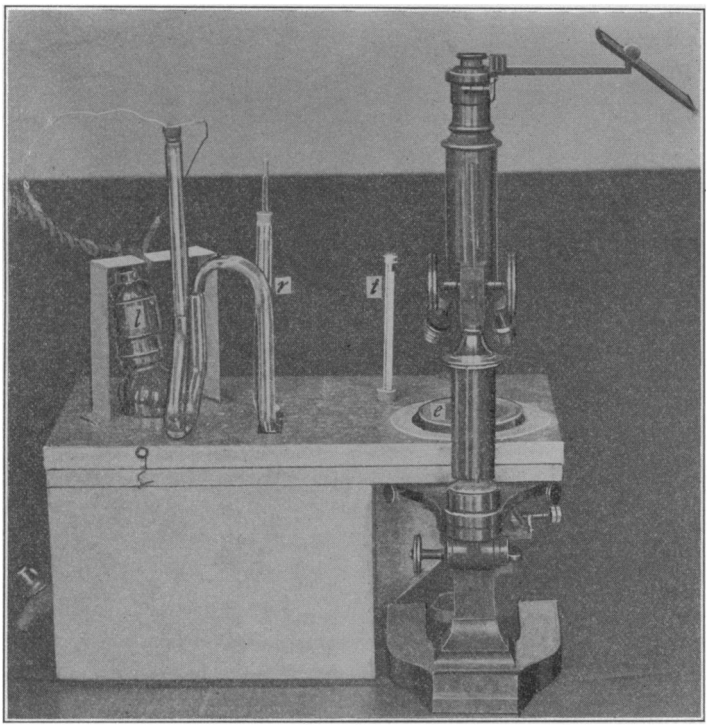

FIG. 1.

water within the incubator, and the way in which this is accomplished can be understood better from the drawing (Fig. 2), in which the greater part of the top and back has been cut away in order to show the internal structure. The shaded part of the drawing represents that portion of the incubator that fits about the microscope stage. For convenience we may speak of three apartments, *A*, *B*, and *C*. *A* is separated from *B* and *C* by a

partition in which are two openings, *m* and *n*. The regulator bulb passes through the former of these holes. In the first apartment the water is heated by the incandescent at *X*; in the second is the egg-cell; and the third is the passage for the water from *B* to *A*. The arrows indicate the direction of the main current of water, and the principle by which this current is maintained is simple. Thus the water on being heated at *X* spreads out over the top of apartment *A* and enters *B* through opening *m*, and consequently flows past the thermoregulator bulb and around the egg-cell. Apartment *C*, in addition to being that portion of

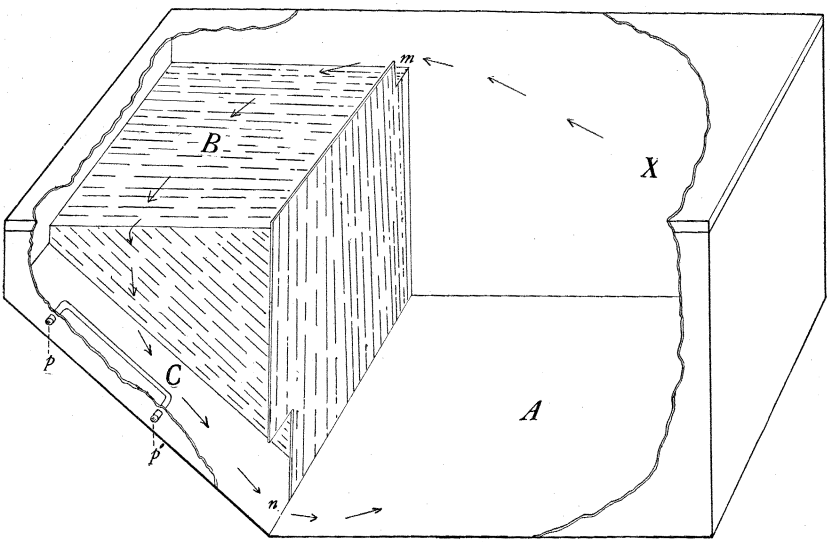

FIG. 2.

the incubator situated farthest from the source of heat, is so constructed that a considerable portion of its surface is exposed for radiation, and hence, the water in this chamber is gradually cooling, and in so doing will flow back through *n* into *A*. It should be added that the lower layer of water in *A* is also heated by the incandescent, at least sufficiently to raise it to a higher temperature than that in the lower part of *C*, and consequently the water in this latter region passes into *A*. At the same time the upper layers of *C* in turn cool and sink. There is maintained throughout the three apartments, therefore, a constant current,

which, although imperceptible, is yet capable of demonstration; for by holding the bulb of a delicate thermometer in the various parts of the incubator the different degrees of temperature are clearly indicated. I have found it advisable to immerse only about a half or two thirds of the incandescent lamp, for in this way the circulation of the water is greatly facilitated.

In constructing the tank, a small pipe (p–p') was soldered into the side of C, so that in case the water did not cool here with sufficient rapidity, a cold stream from a tap or reservoir could be run through the pipe, thus insuring a constant current throughout the three apartments. This precaution was later found unnecessary, at least for temperatures at which the bird's egg incubates.

When the incubator is arranged as described above the temperature of the water in the region of the egg-cell does not vary over 0.2° C., a variation practically negligible for all ordinary purposes. However, if it be desired to maintain a temperature even more constant than this, it could easily be done by making the regulator more sensitive in the ways suggested by Mast, and by constructing the tank so as to prevent the loss of heat by radiation.

This tank, which measures thirteen inches long, seven wide, and six and a quarter high, can be made by any good tinsmith, and the apparatus with all its fixtures can be had at a cost not to exceed five or six dollars.

UNIVERSITY OF CHICAGO.